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Application No.	Ref.	Date
03 254 465.2 - 1237	NJE/G21242EP	11.07.2007
Applicant: SAMSUNG ELECTRONICS CO., LTD.		

Communication pursuant to Article 96(2) EPC

The examination of the above-identified application has revealed that it does not meet the requirements of the European Patent Convention for the reasons enclosed herewith. If the deficiencies indicated are not rectified the application may be refused pursuant to Article 97(1) EPC.

You are invited to file your observations and insofar as the deficiencies are such as to be rectifiable, to correct the indicated deficiencies within a period

of 4 months

from the notification of this communication, this period being computed in accordance with Rules 78(2) and 83(2) and (4) EPC.

One set of amendments to the description, claims and drawings is to be filed within the said period on separate sheets (Rule 36(1) EPC).

Failure to comply with this invitation in due time will result in the application being deemed to be withdrawn (Article 96(3) EPC).

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Moreno, Marta
Primary Examiner
for the Examining Division

Enclosure(s): 4 page/s reasons (Form 2906)
US 6115354

Registered Letter
EPO Form 2001 07.02CSX

The examination is being carried out on the **following application documents:**

Description, Pages

1-18 as originally filed

Claims, Numbers

1-19 as originally filed

Drawings, Sheets

1/8-8/8 as originally filed

The following document (D) is cited by the examiner (see the Guidelines, C-VI, 8.7). A copy of the document is annexed to the communication and the numbering will be adhered to in the rest of the procedure:

D1: US 6,115,354 (2000-09-05).

1. The application does not meet the requirements of **Article 84 EPC**, because claims **1, 2, 6, 7, 8, 9, 10, 15, 16, 17, 18** are not clear.

1.1. The technical terms: " format of a frame", "format of a transmission symbol", "type of the transmission symbol", and the terms: "macro format", "micro format" and "pico format", when referring to the format of the frame, have no well-recognised meaning and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of claims **1, 6, 7, 8, 9, 10, 15, 17, 18** unclear **(Article 84 EPC).**

1.2. Similarly, the relative terms "slow", "fast", when referring to the channel speed and the terms "long", "medium" or "short", when referring to channel length have no well-recognised meaning and leave the reader in doubt as to the meaning of the technical

features to which they refer, thereby rendering the definition of the subject-matter of claims **2, 8, 9, 10, 16** unclear **(Article 84 EPC)**.

2. Furthermore, the above-mentioned lack of clarity notwithstanding, the subject-matter of independent claims **1 and 15** is not new in the sense of **Article 54(1) and (2) EPC**, and therefore the requirements of **Article 52(1) EPC** are not met.

2.1. The document **D1** discloses (the references in parentheses applying to this document):

An orthogonal frequency division multiplexing, OFDM, communication system **(column 1, lines 5-12)**, wherein a method to adapt to channel characteristics comprises the steps of changing the guard interval length **(See Fig. 2A and 2B. This is regarded as implying changing the length of the transmission symbol or one possible interpretation of its "format", which also implies a change of a format of a frame, as the block named as "Data Symbols" in said Fig. 2A or 2B can be interpreted as a frame)** depending on a type of transmission symbol **(column 2, lines 12-20, lines 57-59)** and a radius of a cell, in which communication is performed **(column 2, lines 8-11; from column 2, line 66 to column 3, line 5. It is considered that talking about radius of a cell is identical to talk about coverage or local/regional/national services)**.

The subject-matter of **claim 1** is therefore not new **(Article 54(1) and (2) EPC)**.

2.2. Similar objection to that of point 2.1. applies to independent **claim 15** (see also Fig. 3 of **D1**), which is also not new **(Article 54(1) and (2) EPC)**.

2.3. Should the applicant disagree with the above interpretation of the features of **claim 1** (this also applies to the corresponding features of **claim 15**), the subject-matter of **claim 1** is so close to **D1** as not to be inventive **(Art. 56 EPC)**.

3. Dependent claims **2-14, 16-19** do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the EPC with respect to inventive step, the reasons being as follows:

3.1. As far as it can be understood, the idea behind the present invention is as follows:

First, it is checked whether the symbol to be transmitted is a control symbol, and if so, a first symbol length is assigned (this is also described in document **D1**, see column 2, lines 57-59).
If the symbol is not a control symbol (i.e. it is payload or user data), then the cell radius is determined.
It is noted that it seems that talking about cell radius greater than a first predetermined value is the same as talking about "long" channel length and "macro format". Similarly, talking about a cell radius greater than a second predetermined value is the same as talking about "medium" channel length and "micro format" frame, and a cell radius not greater than the second predetermined value is the same as a "short" channel length and "pico format" frame.
Thus, it is regarded that the invention is based on the idea of determining the type of network structure and then choosing the symbol length accordingly (this is already described in **D1**, where it is taken under consideration whether the network is national, which covers the "long" channel length case, regional, which covers the "medium" channel length case and local, which covers the "short" channel length case. In **D1**, depending on the network, the length of the guard intervals of the data of each OFDM frame is design accordingly, as stated in column 2, lines 8-20).
Document **D1** does not explicitly mentions comparisons of the cell radius with first and second values. However, this is a straightforward possibility in order to determine if the network is national, regional or local, which therefore cannot be seen as providing any inventive step.

Once, it is recognised the type of cell structure or channel length, the invention further considers, in the case of "long" channel length, whether the channel speed is "slow" or "fast", such it is also possible to assign a different symbol length accordingly.
Document **D1** mentions the design of different guard intervals depending on the actually occurring delay time differences (column 2, lines 16-20). To recognise that the channel change speed has an influence in the actually delay time differences, does not appear to provide an inventive step, since that is well known by the skilled persons in the art.

4. It is not at present apparent which part of the application could serve as a basis for a new, allowable claim.

Should the Applicant, nevertheless, consider filing amended claims, the following points should be taken into account:

4.1. The technical problem which is solved by the combination of features of any independent claim should be clear to the reader (**Rule 27(1)(c) EPC**). In terms of the problem and solution approach for the assessment of inventive step, it is important to know what technical problem is solved. If not such problem can be determined, no inventive step can be ascribed.

4.2. When filing amended claims the applicant should at the same time bring the description into conformity with the amended claims (**Art. 84 and Rule 27(1)(c) EPC**). Each embodiment should fall within the scope of some independent claim. The attention of the applicant is drawn to the fact that the application may not be amended in such a way that it contains subject-matter which extends beyond the content of the application as filed (**Article 123(2) EPC**).

4.3. To meet the requirements of **Rule 27(1)(b) EPC**, the document **D1** should be identified in the description and the relevant background art disclosed therein should be briefly discussed.

4.4. To meet the requirements of **Rule 29(1) EPC** the independent claims should be properly cast in the two part form, with those features which in combination are part of the prior art being placed in the preamble.
If the applicant is of the opinion that the two-part form of the claims would be inappropriate he is invited to provide reasons in his reply.

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Dear Sirs

Re: European Patent Application No. 03254465.2-1237
Samsung Electronics Co., Ltd.

In response to the official communication dated 11 July 2007, we enclose replacement pages 1 and 2 of the description, together with a replacement set of claims. We also enclose new page 2a of the description.

In the replacement claims, claim 1 has been amended to recite that it is the length of the transmission symbol which is changed according to the method. Basis for this amendment can be found in Figure 2 and the description thereof as filed.

Claim 1 has also been amended to clarify that dependence on "a type of the transmission symbol" is dependence on "whether the transmission symbol is used for control". Basis for this amendment can be found at page 4, lines 19 to 24 of the description as filed.

Finally, claim 1 has been amended to recite that changing the length of the transmission symbol comprises changing a length of a cyclic prefix of the symbol and a length of transmission data of the symbol. Basis for this amendment can be found throughout the description as filed, and particularly at page 11, lines 2 to 10.

Clarifying amendments have been made throughout the claims. In particular, the expressions "macro format", "micro format" and "pico format" have been amended to recite the specific technical features of these formats, based on claims 8 to 10. Claims 8 to 10 have accordingly been deleted and the remaining claims renumbered.

The independent apparatus claim, claim 12 (former claim 15) has been amended in line with claim 1.

A number of clarity objections have been raised in paragraphs 1.1 and 1.2 of the communication. In response to these objections, the terms "format of a frame", "format of a transmission symbol", "type of the transmission symbol", "macro format", "micro format" and "pico format" have been deleted or replaced with clear technical features.

With regard to the terms "slow", "fast" when referring to channel speed and the terms "long", "medium" and "short" when referring to channel length, we agree that these terms are relative terms. However, we submit that, when used together, i.e. in relation to one another, the terms have a clear meaning. For example, a "fast channel speed" represents a channel speed range that is greater than a channel speed range represented by a "slow channel speed".

The relative terms identified by the Examiner could be replaced by less meaningful expressions such as first and second channel speed ranges, with the relationships therebetween defined, but it is considered that this would result in excessively long claim language and therefore reduced clarity.

We accordingly submit that all of the claims comply with Article 84 EPC.

Former claim 1 has been objected to as lacking novelty over D1 (US 6115354). However, we submit that the amended claims are both novel and inventive over the cited prior art.

In particular, amended claim 1 recites the novel feature that both the length of a cyclic prefix and the length of transmission data are changed to adapt the communication method to channel characteristics. In contrast, according to the method of D1, the length of the transmission data is maintained constant regardless of the channel characteristics (see Figures 2a to 2c).

This novel feature provides the technical effect that inter-symbol interference can be overcome, while at the same time minimizing the transmission inefficiency caused by lengthening the cyclic prefix. This is described in some detail at page 10, line 14 to page 11, line 10 of the description as filed.

The problem solved by the invention is therefore how to prevent inter-symbol interference in an orthogonal frequency division multiplexing communication method without substantially reducing the communication efficiency. The invention solves this problem by changing both the length of the cyclic prefix and the transmission data of a transmission symbol. In this way, the degree of overhead due to the cyclic prefix is substantially fixed (see page 11, lines 7 to 10 and Table 1 of the description as filed).

D1 does not provide any hint that the above problem may be solved by changing a length of transmission data of the transmission symbol. We accordingly submit that amended claim 1 involves an inventive step. The above remarks apply equally to the amended independent apparatus claim, claim 12, which is accordingly also novel and inventive.

The independent claims have been separated into the two-part form. Reference numerals have been inserted throughout the claims, where appropriate.

The description has been amended at pages 1 to 2a to bring the statement of invention into conformity with the amended claims. The description has also been amended at page 1 to introduce and briefly summarise the relevant content of D1.

We submit that this application is now in order for allowance, and issuance of a communication under Rule 51(4) EPC is respectfully requested. As a precautionary measure, we request that oral proceedings be appointed before any decision is taken to refuse this application.

Yours faithfully
Elkington and Fife LLP

James Anderson

ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING COMMUNICATION METHOD AND APPARATUS ADAPTED TO CHANNEL CHARACTERISTICS

The present invention relates to orthogonal frequency division multiplexing (OFDM) communication, and more particularly, to an OFDM communication method and apparatus adapted to channel characteristics.

With a variety of environments in which a communication method is used, the communication method is required to be effective even if Doppler frequency or delay spread changes. However, since an optimum physical layer varies with channel change speed and delay spread, it is difficult to efficiently support a communication method using a single physical layer. Accordingly, a hierarchical cell including a variety of cells is used in a single communication method.

When using such a hierarchical cell, channels for users corresponding to different layers have different characteristics. For example, when a cell has a large radius, delay spread is long, and a channel change speed is fast. Accordingly, if the same modulation method is applied to different layers, a communication method cannot be adapted to the channel characteristics. In order to overcome this problem, a conventional communication method uses OFDM when the channel change speed is slow and uses code division multiple access (CDMA) when the channel change speed is fast. As described above, when using the conventional communication method, two modems of different types need to be provided for a terminal. Accordingly, the conventional communication method increases the complexity of transmitter and receiver of a terminal. In addition, since signals having different spectrum characteristics are used, the conventional communication method is difficult to develop, and radio resource management such as handover and association is difficult.

US 6,115,354 discloses an orthogonal frequency division multiplexing communication method in which a guard interval between data symbols is shorter than a guard interval between control symbols, and in which the length of the guard interval between data symbols can be varied.

According to an aspect of the present invention, there is provided an orthogonal frequency division multiplexing communication method which adapts to

channel characteristics, the method comprising changing a length of a transmission symbol depending on whether the transmission symbol is used for control and on a radius of a cell in which communication is performed, wherein the method is characterized in that changing the length of the transmission symbol comprises changing a length of a cyclic prefix of the transmission symbol and changing a length of transmission data of the transmission symbol.

The invention thus provides an orthogonal frequency division multiplexing (OFDM) communication method through which at least one of the length of a transmission symbol, the format of a transmission symbol, and the format of a frame is changed to adapt to channel characteristics such as channel change speed and channel spread.

According to another aspect of the present invention, there is provided an orthogonal frequency division multiplexing communication apparatus arranged to adapt to channel characteristics, the apparatus comprising: a symbol inspector, arranged to inspecting a transmission symbol to determine whether the transmission symbol is used for control and outputting the result of the inspection as a first control signal; and a symbol and format converter, arranged to change a length of a transmission symbol depending on the first control signal and on a radius of a cell in which communication is performed, wherein the apparatus is characterized in that the symbol and format converter is arranged to change a length of a cyclic prefix of the transmission symbol and change a length of transmission data of the transmission symbol.

The invention thus also provides an OFDM communication apparatus for performing the OFDM communication method of the invention, which is adapted to the channel characteristics.

The above and other features and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a flowchart of an orthogonal frequency division multiplexing (OFDM) communication method adapted to channel characteristics according to a first embodiment of the present invention;

FIG. 2 is a diagram showing an example of a single frame including symbols having various lengths;

FIG. 3 is a flowchart of an OFDM communication method adapted to channel characteristics according to a second embodiment of the present invention;

FIG. 4 is a diagram showing an example of a macro format;

FIG. 5 is a diagram showing an example of a micro format;

FIG. 6 is a diagram showing an example of a pico format;

FIG. 7 is a flowchart of an embodiment of step 16 shown in FIG. 1 according to the present invention;

FIG. 8 is a diagram showing a hierarchical cell structure;

FIG. 9 is a diagram showing an example of a usual multiplex carrier wave transmission symbol;

CLAIMS

1. An orthogonal frequency division multiplexing communication method which adapts to channel characteristics, the method comprising changing a length of a transmission symbol depending on whether the transmission symbol is used for control and on a radius of a cell in which communication is performed, wherein the method is characterized in that changing the length of the transmission symbol comprises changing a length of a cyclic prefix of the transmission symbol and changing a length of transmission data of the transmission symbol.

2. The communication method of claim 1, wherein changing the length of a transmission symbol comprises the following steps:

a. determining whether the transmission symbol is a symbol that is used for a control channel (10);

b. if it is determined that the transmission symbol is the symbol that is used for a control channel, determining a first symbol containing control information as the transmission symbol (12);

c. if it is determined that the transmission symbol is not the symbol that is used for a control channel, determining whether the cell radius is greater than a first predetermined value (14);

d. if it is determined that the cell radius is greater than the first predetermined value, determining a second symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is long, or a third symbol, which is suitable to channel characteristics where the channel change speed is fast and the channel length is long, as the transmission symbol (16);

e. if it is determined that the cell radius is not greater than the first predetermined value, determining whether the cell radius is greater than a second predetermined value (18);

f. if it is determined that the cell radius is greater than the second predetermined value, determining a fourth symbol, which is suitable to channel characteristics where the channel change speed and the channel length are medium, as the transmission symbol (20); and

g. if it is determined that the cell radius is not greater than the second predetermined value, determining a fifth symbol, which is suitable to channel characteristics where the channel change speed is slow and the channel length is short, as the transmission symbol (22),

wherein the second predetermined value is less than the first predetermined value, a length of the fourth symbol is less than a length of the second symbol, and a length of each of the first, third, and fifth symbols is less than the length of the fourth symbol.

3. The communication method of claim 2, wherein the length of each of the second, third, fourth, and fifth symbols is an integer multiple of the length of the first symbol.

4. The communication method of claim 2, wherein the length of each of the second, third, and fourth symbols is an integer multiple of the length of the fifth symbol.

5. The communication method of any one of claims 2 to 4, further comprising the step of adjusting the length of the determined transmission symbol by changing the number of carrier waves

6. The communication method of claim 2, wherein:

step d. comprises, if it is determined that the cell radius is greater than the first predetermined value, determining the second or third symbol as the transmission symbol and converting the format of the frame into a format (90) comprising:

the first symbol, which contains control information;

the second symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is long; and

the third symbol, which is suitable to channel characteristics where the channel change speed is fast and the channel length is long;

step f. comprises, if it is determined that the cell radius is greater than the second predetermined value, determining the fourth symbol as the transmission symbol and converting the format of the frame into a format (92) comprising:

the first symbol, which contains control information; and

the fourth symbol, which is suitable to channel characteristics where a channel change speed and a channel length are medium; and

step g. comprises, if it is determined that the cell radius is not greater than the second predetermined value, determining the fifth symbol as the transmission symbol and converting the format of the frame into a format (94) comprising:

the first symbol, which contains control information; and

the fifth symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is short.

7. The communication method of claim 1, wherein changing the length of a transmission symbol comprises the steps of:

h. determining whether the cell radius is greater than a first predetermined value (70);

i. if it is determined that the cell radius is greater than the first predetermined value, converting (72) the format of the frame into a format (90) comprising;

a first symbol, which contains control information;

a second symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is long; and

a third symbol, which is suitable to channel characteristics where the channel change speed is fast and the channel length is long;

j. if it is determined that the radius cell is not greater than the first predetermined value, determining whether the radius cell is greater than a second predetermined value (74);

k. if it is determined that the cell radius is greater than the second predetermined value, converting (76) the format of the frame into a format (92) comprising:

the first symbol, which contains control information; and

the fourth symbol, which is suitable to channel characteristics where a channel change speed and a channel length are medium; and

l. if it is determined that the cell radius is not greater than the second predetermined value, converting (78) the format of the frame into a format (94) comprising:

the first symbol, which contains control information; and

the fifth symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is short,

wherein the first predetermined value is greater than the second predetermined value.

8. The communication method of claim 2, wherein step d. further comprises the steps of:

d1. if it is determined that the cell radius is greater than the first predetermined value, determining whether the channel change speed is greater than a predetermined speed (110);

d2. if it is determined that the channel change speed is not greater than the predetermined speed, determining the second symbol as the transmission symbol (112); and

d3. if it is determined that the channel change speed is greater than the predetermined speed, determining the third symbol as the transmission symbol (114).

9. The communication method of claim 8, wherein the second symbol determined as the transmission symbol in step d2. comprises:

a first cyclic prefix, which contains an end portion of transmission data (150);

a first transmission signal, which contains the transmission data (158); and

a first cyclic suffix, which contains a beginning portion of the transmission data (154).

10. The communication method of claim 8, wherein the third symbol determined as the transmission symbol in step d3. comprises:

a first cyclic prefix, which contains a plurality of end portions of transmission data and a beginning portion of the transmission data (170);

a first transmission signal, which contains the transmission data (172);

a second transmission signal, which contains the transmission data (174); and

a first cyclic suffix, which contains the beginning portion of the transmission data (176).

11. The communication method of claim 8, wherein the third symbol comprises:

a first cyclic prefix, which contains a plurality of end portions of transmission data (190);

a first transmission signal, which contains the transmission data (192);

a second transmission signal, which contains the transmission data (194); and

a first cyclic suffix, which contains a plurality of beginning portions of the transmission data (196).

12. An orthogonal frequency division multiplexing communication apparatus arranged to adapt to channel characteristics, the apparatus comprising:

a symbol inspector (210), arranged to inspecting a transmission symbol to determine whether the transmission symbol is used for control and outputting the result of the inspection as a first control signal; and

a symbol and format converter (212), arranged to change a length of a transmission symbol depending on the first control signal and on a radius of a cell in which communication is performed,

wherein the apparatus is characterized in that the symbol and format converter (212) is arranged to change a length of a cyclic prefix of the transmission symbol and change a length of transmission data of the transmission symbol.

13. The communication apparatus of claim 12, wherein the symbol and format converter (212) comprises:

a first comparator (230), for comparing the cell radius with a first predetermined value in response to the first control signal and outputting the result of the comparison as a second control signal;

a second comparator (232), for comparing the cell radius with a second predetermined value in response to the second control signal and outputting the result of the comparison as a third control signal; and

a first converter (234), for determining one among first, second, third, fourth, and fifth symbols as the transmission symbol in response to the first, second, and third control signals and outputting the determined symbol,

wherein the second predetermined value is less than the first predetermined value, the first symbol contains control information, the second symbol is suitable to

channel characteristics where a channel change speed is slow and a channel length is long, the third symbol is suitable to channel characteristics where the channel change speed is fast and the channel length is long, the fourth symbol is suitable to channel characteristics where the channel change speed and the channel length are medium, and the fifth symbol is suitable to channel characteristics where the channel change speed is slow and the channel length is short.

14. The communication apparatus of claim 12, wherein the symbol and format converter (212) comprises:

a third comparator (250), for comparing the cell radius with a first predetermined value and outputting the result of the comparison as a fourth control signal;

a fourth comparator (252), for comparing the cell radius with a second predetermined value in response to the fourth control signal and outputting the result of the comparison as a fifth control signal; and

a second converter (254), for converting the format of the frame into one of a first format (90), a second format (92), and a third format (94) in response to the fourth and fifth control signals,

wherein the first predetermined value is greater than the second predetermined value, and wherein:

the first format (90) comprises:

a first symbol, which contains control information;

a second symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is long; and

a third symbol, which is suitable to channel characteristics where the channel change speed is fast and the channel length is long;

the second format (92) comprises:

a first symbol, which contains control information; and

a fourth symbol, which is suitable to channel characteristics where a channel change speed and a channel length are medium; and

the third format (94) comprises:

a first symbol, which contains control information; and

a fifth symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is short.

15. The communication apparatus of claim 13, wherein the first converter (234) is arranged to convert the format of the frame into one of a first format (90), a second format (92), and a third format (94) in response to the second and third control signals, and wherein:

the first format (90) comprises:

the first symbol, which contains control information;

the second symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is long; and

the third symbol, which is suitable to channel characteristics where the channel change speed is fast and the channel length is long;

the second format (92) comprises:

the first symbol, which contains control information; and

the fourth symbol, which is suitable to channel characteristics where a channel change speed and a channel length are medium; and

the third format (94) comprises:

the first symbol, which contains control information; and

the fifth symbol, which is suitable to channel characteristics where a channel change speed is slow and a channel length is short.

16. The communication apparatus of claim 13, wherein the first converter (234) comprises a fifth comparator (270), for comparing the channel change speed with a predetermined speed in response to the second control signal and outputting the result of the comparison as a sixth control signal, and a format converter (272), for converting the format of the determined symbol in response to the sixth control signal.